University of Minnesota
Institute of Agriculture
Agricultural Short Courses
St. Paul 1, Minnesota

ABSTRACT OF
EIGHTEENTH ANNUAL
ANIMAL NUTRITION
SHORT COURSE

SEPTEMBER 9, 10, 1957
PETERS HALL
ST. PAUL CAMPUS, ST. PAUL

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ACKNOWLEDGMENT

A contribution from the
Northwest Feed Manufacturer's Association
has aided greatly in making this publication possible

PROGRAM

PETERS HALL AUDITORIUM

Monday, September 9, 1957

SWINE NUTRITION

C. A. Scott, presiding
President, Northwest Feed Manufacturers Association

a.m.

8:00 Registration, Peters Hall Lobby
Fees: $8.00 for the course, $4.00 for one day

9:00 Welcome . . . . H. J. Sloan*
Director, Agricultural Experiment Station

9:40 Formulating rations and protein supplements for the essential amino acids required by swine. . . . . R. J. Meade*
Associate Professor, Department of Animal Husbandry

10:30 Enzymes in baby pig nutrition . . . . A. J. Wood
Professor, Animal Nutrition and Director, Central Depot for Experimental Animals, University of British Columbia, Vancouver 8, Canada

RUMINANT NUTRITION

E. L. Johnson,* presiding
Professor and Head, Department of Poultry Husbandry

p.m.

1:15 Energy in dairy cattle feeding. . . . . J. D. Donker*
Associate Professor, Department of Dairy Husbandry

2:00 Rumen microbiology as related to concentrate and roughage feeding. . . . . C. F. Huffman
Professor, Department of Dairy Husbandry, Michigan State University, East Lansing, Michigan

2:45 Value of grain screenings for cattle. . . . . A. J. Wood

3:30 Thyroprotein feeding. . . . . Panel
Moderator: C. L. Cole,* Professor and Head, Department of Dairy Husbandry
R. Ahlin, Doughboy Industries, New Richmond, Wisconsin
L. V. Burns, Technical Director, Agri-Tech, Inc., Kansas City, Missouri

J. D. Donker*
C. F. Huffman
R. J. Meade*
A. J. Wood

Tuesday, September 10

POULTRY NUTRITION

A. L. Harvey,* presiding
Professor, Department of Animal Husbandry

a.m.

9:00 Nutrition of cage layers. . . . . R. H. Thayer
Professor, Department of Poultry Husbandry, Oklahoma A. & M. College, Stillwater, Oklahoma

9:30 Management and economics of layer programs in North Central states. . . . . D. H. Sherwood
Poultry Nutritionist, General Mills, Indianola, Iowa

9:45 Recess

10:00 Panel discussion. . . . .
Moderator: E. L. Johnson*
D. H. Sherwood
R. H. Thayer
F. M. Crane, Nutrition Analyst, Land O'Lakes Creameries, Inc., Minneapolis
M. E. Dreyer, Manager, Premium Egg Producing Company, Gaylord

11:00 Antibiotics for layers . . . . C. W. Carlson
Professor, Department of Poultry Husbandry, South Dakota State College, Brookings, South Dakota

11:30 Results of turkey hemorrhage survey. . . . . P. E. Waibel*
Associate Professor, Department of Poultry Husbandry

p.m.

C. L. Cole,* presiding
Professor and Head, Department of Dairy Husbandry

1:45 Latest concepts in turkey nutrition. . . . . R. H. Thayer

2:15 Energy - protein relationships with growing turkeys . . . . C. W. Carlson

3:00 Informal round table discussion groups. . . . .
Poultry -- C. W. Carlson, D. H. Sherwood, R. H. Thayer, and P. E. Waibel* (leader)
Swine -- A. J. Wood and R. J. Meade* (leader)
Beef and dairy cattle -- C. F. Huffman and J. D. Donker* (leader)

*University of Minnesota

SPECIAL EXHIBITS

Department of Dairy Husbandry

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FORMULATING RATIONS AND PROTEIN SUPPLEMENTS FOR THE ESSENTIAL AMINO ACIDS REQUIRED BY SWINE

R. J. Meade, Associate Professor
Department of Animal Husbandry
University of Minnesota

The compounding of rations and protein supplements for growing swine is largely a matter of formulating the protein supplement portion of the ration to correct the amino acid deficiencies of the energy portion -- usually corn. The protein of corn is deficient in tryptophan and lysine, and it may be deficient in methionine, isoleucine and threonine. Hence, the choice of protein supplemental feeds should be based on their ability to supplement or correct essential amino acid deficiencies of the energy feed. An exception to this appears in the case of barley which may contain enough of all of the essential amino acids except lysine, and possible methionine.

Under practical conditions a high percentage of hogs are fed yellow corn and protein supplement free-choice, or the supplement is hand-fed or mixed with ground corn to control the protein content of the ration consumed.

There now appears to be sufficient information available on the protein requirements of pigs to justify the recommending of a 16% protein ration for weanling age pigs. The protein portion of the ration must contain adequate amounts of the essential amino acids. Based upon the results of many research workers the amino acid requirements of weanling age pigs fed such a ration are approximately: 0.20% arginine (the pig can synthesize the remainder of its requirement.), 0.20% histidine. 0.54% isoleucine, 0.84% leucine, 0.80% lysine, 0.28% methionine, 0.58% phenylal anine (plus tyrosine), 0.50% threonine, 0.13% tryptophan and 0.50% valine.

Any protein supplement or protein supplemental feed must then supply enough of the previously mentioned critically deficient amino acids of yellow corn to provide a final ration whech contins at least the above amounts of those amino acids when the two are used together. Corn contains approximately 0.07% of tryptophan and soybean oil meal contins approximately 0.52% of this amino acid. A 16% crude protein ration based upon these two ingredients would contain approximately 0.18% of tryptophan which has been demonstrated to be adequate for growing pigs. Thus a 40% protein supplement would have to contain approximately 0.34% of tryptophan to meet the pig's requirement, but would need to contain nearly 0.54% of tryptophan to make it compare favorably with 45% solvent soybean oil meal. In addition to soybean oil meal, linseed oil meal, fishmeal and bloodmeal are good to excellent sources of tryptophan. Meat and bone scraps appear to be somewhat limiting in both amount and availability of tryptophan.

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protein ration the mixture will contain approximately 0.77% of lysine which is below the suggested allowances, but which has been shown to be an adequate amount of lysine for growing pigs. On the other hand, supplementation of corn linseed oil meal to make a 16% protein diet supplies only 0.45% of lysine in the diet. A 40% drylet protein supplement, making up approximately 24% of a 16% protein diet, should contain approximately 2.5% of lysine. Tankage, fishmeal, meat scraps, bloodmeal and soybean oil meal are good to excellent sources of lysine. When protein supplemental feeds of high lysine content are used in the protein supplement it is possible to include feeds as linseed meal or wheat middlings which contain lesser amounts of lysine in a 40% drylot supplement.

A typical 16% protein corn-soybean oil meal type of ration will contain approximately 0.26% of methionine which appears to be adequate when the ration also contains 0.3% of cystine. Most commonly used protein supplemental feeds when used properly with one another to make up a protein supplement with which to supplement corn will provide a final ration containing at least the recommended amount of methionine.

Detailed information will be presented on the amino acid requirement and allowances for growing pigs. Information on the ability of separate protein feeds to complement one another to provide adequate amounts of the essential amino acids in the protein supplement will also be presented.

ENZYMES IN BABY PIG NUTRITION

A. J. Wood, Professor
Animal Nutrition, Director Central Depot for Expcrimental Animals
University of British Columbia
Vancouver 8 British Columbia

Within the past ten years there has been a renewed interest in the study of nimal growth and in the efficiency of growth processes. In Canada we had come o accept six months as the time required to produce a 200 pound bacon hog with feed efficiency of about 3.5 pounds of feed per pound of gain. Recent research ndicated that this period can be reduced to four months with at least a fifteen ercent improvement in feed efficiency.

Put in other terms, there is good reason to believe that in most cases we have ot yet approached the full genetic potential for growth possessed by our present reeds of livestock. I most confess that this is a hazardous statement for a nutritionist o make in one of the lecture halls of this University where the famous new Minnesota wine breeds were conceived and developed.

The advent of antibiotic feeding, a more detailed knowledge of swine nutritive re- uirements, improved sanitation and management procedures and improved genetic orth in our swine population have all contributed to the progressive gains we have ade in swine production. As with all such gains each step forward makes each ubsequent step more difficult. To take the familiar DC3 aircraft from 150 miles er hour and expand it to the DC6 with three times the capacity and twice the speed as a real achievment for the aircraft industry. To again double the capacity and ouble the speed is proving to be a tremendous challenge to the genius of aircraft esigners. Their research and development costs are astronomic in terms of our inking when we plan animal research.

A few years ago we felt that we had reached the DC6 stage in terms of swine owth and would have to put forward a much greater effort to make the improve- ents that the expanding livestock industry demand. Our research and develop- ent programme was fairly easy to conceive but its successful prosecution esented real difficulties.

Growth curve studies showed beyond question that a definite slowing up of owth occurs in the suckling pig between its second and third week of life. To stain the relatively fantastic rate of growth achieved during the first two weeks life on a milk diet it was apparent that the design of assimilable and nutritionally equate creep feeds was essential. The best sow that the animal geneticist could velop would face the physiological impossibility of producing twenty to thirty unds of milk per day to sustain maximun potential growth rate in her litter of n pigs.

The provision of an assimilable creep feed required an intensive study of the digestive enzyme system of the suckling animal. A knowledge of these enzyme systems would permit the formulation of creep rations from ingredients that can be digested and assimilated. Our studies to date indicate that the milk-sugar digesting enzyme lactase is present in large amounts in the small intestine during the first two weeks of life and that it then disappears rapidly. Paralleling the disappearance of lactase there is a marked increase in the level of the other enzymes necessary for the breakdown of starch and other carbohydrates. The level of the fat splitting enzyme lipase is high at birth remains high to eight weeks of age.

The recent reports on the use of proteolytic enzymes such as pepsin suggest that similiar detailed studies are necessary on this group of digestive agents: Other studies have shown that the nature of the dietary fat can markedly influence its suceptibility to digestion and/or absorption. As the animal becomes older its ability to handle the longer chain fats appears to increase. The precise time at which this change in the digestive system occurs is not yet known with certainty. A recent report by Cunningham and Brison suggests that no improvement in the digestibility of the fish meal or soybean proteins occurs when proteolytic enzymes are added to swine creep rations. These results are contrary to what might have been expected from Catrons reports. The same workers have also noted that the 2 to 5 day old pig can digest maltase readily. Fischer and Sutton have shown that the rat can readily digest cellobiase. They have also shown that calcium gluconate inhibits intestinal lactase but does not inhibit sucrase and cellobiase. Most of the reported work to date has dealt with the digestive enzymes as such and has not touched on the role of absorption in the assimilation of the digested products. Our own recent demonstratio of the absorption of amino acids from the rumen of the goat would indication that much additional research is needed on the nature of the absorption mechanisms.

To summarize, it is quite apparent that the sum total of our present knowledge on this subject is wholly inadequate to permit immediate application. It is equally apparent that rich rewards for the feed industry will be forthcoming if and when the essential basic research is concluded.

ENERGY IN DAIRY CATTLE FEEDING

J. D. Donker, Associate Professor
Department of Dairy Husbandry
University of Minnesota

Nutrient energy is the fuel of the body which enables the many processes of the body to be carried on. Many nutrient compounds can be oxidized in the body and so release energy for body use. We generally think of carbohydrates and fats as the main energy sources, but protein can also serve as a source of energy. The ruminant animal is set apart because it can, by virtue of its "fermentation vat", digest to a considerable extent the complex carbohydrates and utilize much of the energy released from them. e.g. cellulose. This process of bacteriological digestion is quite limited in species not haveing a rumen.

The practical application of the scientific information concerned with energy needs and uses in dairy cattle feeding encompasses two concepts - nutritional efficiency and economic efficiency. High nutritional efficiency does not necessarily indicate high efficiency, economically speaking.

Whatever combination of functions an animal is performing - growing, maintaining itself, working, growing a fetus, or producing milk, etc. - energy is of the prime consideration in feeding that animal. Productive performance of livestock is dependent majorally upon an energy intake in excess of that required for maintenance purposes. Such sources of energy must, in the long run, be gotten from dietary sources.

There are certain relationships among various nutrient principles which can be expressed by ratio, e.g., poultry nutritionists speak of a calorie-to-protein ratio. In animal nutrition, an almost synonymous term is nutritive ratio, 1 part digestible protein to x parts digestible no-nitrogenous nutrients. In milking cows, contrasted to most growing animals, as productive performance is increased by increased nutrient intake, the proportion of protein needed in the ration increases and it does not suffice to hold the energy-to-protein ratio constant as the energy content of a ration is increased. Protein content must increase at a somewhat faster rate. This is because the nutritive requirement for milk production in terms of protein is more demanding than maintenance requirements. As has been mentioned, productive performance is dependent upon energy intake in excess of maintenance requirements. Of equal importance is the fact that performance is often limited by feed intake capacity and the most limiting nutrient is energy. We shall return to this limitation shortly, after another observation regarding protein-energy relationships. Considerable energy can be sotred in the body for later production needs. Only small amounts of protein can be stored, and little protein is available for productive purposes in times of a negative balance During the early part of lactation when most cows are in negative energy balance, every effort should be made to provide protein according to production requirements as these needs must be met day be day. Therefore, based on intakes, a nutritive ratio is of little practical importance in this circumstance.

To exemplify the magnitude of energy needs in terms of feedstuffs and other nutrients, an example is offered. A thousand-pound cow required 8.0 lbs. TDN and .6 lbs. digestible protein, the nutrient needed in second largest quantity (excluding air and water), or over 13 times as much energy as protein. Generally, the relationship between protein and energy is illustrated by a requirement demonstrating a narrower ratio. To illustrate: In the production of low-test milk (3% B.F.) the ratio between TDN and protein is considerable lower, i.e., 7. It can be quite easily seen that even a cow producing very heavily required about 9.0 times as much digested feed for energy as digested protein. In terms of a standard-type high production ration (nutrient source -60% forage, 40% concentrate), this would be a ration containing about 60% TDN (10-12% dry matter equivalent), with a content of digestible protein of 7.0%.

Chemically speaking, a ration with such a protein: energy content is easy to compound using materials low in cost. Logically, it follows that if enough energy is consumed from such a chemically balanced ration, there will be consumed sufficient of the other major nutrients also. However, physical and physiological limitations restrict the intakes of feedstuffs in such manner that rarely, if ever, could a high-producing cow early in lactation meet her nutrient requirements from forage or even from rations made up with a high proportion of concentrates. It is not enough to be able to meet the daily average requirements for each day, as an animal in negative balance adjusts production against intake after depleting reserves. To most nearly meet the daily need on a daily basis, it becomes necessary to think in terms of a ration which is highly concentrated in nutrients. A more concentrated ration usually enables a greater intake to be achieved, and therefore a higher level of performance can be achieved and maintained. Increasing the energy content of a ration does achieve high nutritional efficiency, providing that ration is consumed in large quantity. Economic efficiency is certainly enhanced in most cases by the first few additions of concentrate to a forage ration. However, as grain feeding is increased to the point where an animal is receiving more grain than one pound to five of milk, economic efficiency falls rapidly in most circumstances of costs of feedstuff and prices for milk. This relationship can be appreciated when one considers that the first few additions of grain allow milk for each additional pound of grain added. n The total additional cost to a ration caused by adding grain is not as large as the grain cost itself, as such grain replaces forage in increasing amounts as it is added to a ration.

What are the energy needs of growing animals needed as replacement stock? The attainment of sexual maturity is governed mainly by age and level of nutrition. Animals on a high plane of nutrition become sexually mature much earlier, coming into estrus two or three months earlier than those on a low plane of nutrition. If the plane of nutrition is too low, conception is unduly prolonged. It has been found by several investigators in this country and abroad, that heifers raised on a relatively low plane of nutrition actually outproduced control animals of comparable age which freshened at the same time, but which had been well fed.

'eeding after milking ensued, or in some instances, two or three months previous o calving was similar to both groups. While the animals fed on the low plane were 00 pounds lighter at first calving, in many instances most of this weight was gained eck during the first and second lactations. By the end of three lactations, the animals raised on the low level had produced slightly more, or equal amounts, of nilk compared to the "well-raised" heifers.

We have been talking about certain relationships of energy to productive performance as if it is all a rather simple matter of balancing units of nutrient requirements aginst intake of nutrient units in feed. In reality, there reamins much o be desired concerning the unit in which requirements for animals are recorded nd by which feedstuffs are evaluated. TDN is the common unit linking animal needs nd feedstuff sources of energy used most commonly in animal feeding in this country. 3y the fact that this unit is not universally accepted today, 55-60 years after its introduction, would lead one to be critical of its value. Simply stated, the TDN value f feedstuff is derived from information about what the animal does to the feed. Of nuch greater concern to the feeder is- what will the feed do for the cow, the net nergy concept. There are those who would argue that the TDN value gives a net nergy evaluation to a feedstuff. It has been quite well demonstrated that for most roductive needs, a unit of TDN in the form of low-fiber feed is much more valuable or productive purposes than a unit from a high fiber feed. Much heat is produced nd wasted as a result of the high fiber content of certain feedstuffs. They are not speaking aginst the use of forage materials as a source of nutrients for dairy attle. They wish to emphasize, however, that whenever one uses the TDN unit o evaluate roughages or forages, the material is overevaluated insofar as the igh-producing cow is concerned.

A net energy scheme of measuring energy values of feedstuffs, individually and n combination, is in use in Europe in either one of two forms. In one case, a tandard feedstuff, barley, is used as a reference standard, and other feeds are ompared to it. In another system, the reference material is a purified energy ubstance, starch, and substances are compared with it and given starch values.

The greatest difficulty with the net energy concept of evaluating a feedstuff s that the value differs with various productive levels and the type of function for hich it is utilized, and how the feed in question is blended into the ration. Thus, ere is no one value for a feedstuff under a scheme of evaluating feedstuffs on e basis of what it would do for the animal. Whether or not this is a valid criticism of a system of evaluating feedstuffs is seriously questioned. It is already pparent that different forms of TDN have divergent values according to their ource and use. It is a simple step to adjust net energy values of feedstuffs ccording to their use, once these values have been adequately determined.

VALUE OF GRAIN SCREENINGS FOR CATTLE

A. J. Wood, Professor
Animal Nutrition, Director Central Depot for Experimental Animals
University of British Columbia
Vancouver 8, British Columbia

Dr. Wood offers the following summary of information of this subject. This summary is based on the questions that have arisen in connection with this feed product over the past five years. The facts stated below are gathered from research and field records accumulated over this period.

(1) Raw Refuse Screenings: A long series of proximate analysees were carried out on run of elevator refuse screenings produced in the Port of Vancouver. The period covered by the samplings was October, 1948 to the present. Moisture content has ranged from 8.7% to 15.3% crude protein on a nitrogen times 6.25 basis from 8.3% to 14.8%, crude fat from 3% to 7.8%, crude fiber from 7.8% to 24%, Ash from 6.6% to 9.2% and nitrogen free extract from 41% to 52%. The mean for all determinations carried out to date with corresponding figures for oats, wheat and barley are given in Table I.

Table I The composition of Refuse Screenings Relative to Wheat, Oats, and Barley.

Feeding Stuff	Moisture	Protein nx6.25	Fat	Nitrogen Free Extract	Fiber	Ash
Refuse Screenings	10.7	10.5	5.3	47.5	17.7	7.9
Wheat	10.5	13.2	1.9	69.9	2.6	1.9
Oats Pacific	8.8	9.0	5.4	62.1	11.0	3.7
Barley (Pacific)	10.2	8.7	1.9	70.9	5.7	2.6

Fractionation of representative samples of refuse screenings indicate that they will contain from forty to fifty per cent of weed seeds.

(2) Ground Fractionated Refuse Screenings: The screenings that are used for pellet production are partially cleaned to remove chaff and are ground to pass a screen This operation is carried out to facilitate pelleting and to ensure uniformity in the final product. The effect of this fractionation and grinding procedure is brought out in Table II below.

Table II: Proximate Composition of Production Runs of Refuse Screenings Pellets Manufactured from Fractionated Refuse Screenings

Date of Production	Protein	Fat	Fiber
Dec. 1/53	11.4	6.3	14.5
Jan. 4/54	11.7	7.4	15.3
Apr. 5/54	12.8	5.1	14.1
May 4/54	11.7	5.9	13.4
June 9/54	12.7	5.9	14.3
July 12/54	12.8	6.4	11.7
Sept. 3/54	11.8	6.2	13.8
Oct. 4/54	12.3	6.2	12.9
July 16/56	12.6	6.8	13.4

The figures presented have been taken at random from a long series of analysees on production runs of refuse screenings pellets. It should be noted that the fractionatio procedure has had the effect of removing a part of the crude fiber in the form of chaff and a part of the ash to yield a very uniform product.

(3) Weed Seeds in Refuse Screenings: As mentioned above the raw refuse screenings contain appreciable amounts of various weed seeds. It is these weed seeds that contribute a major portion of the nutritive value of the final refuse screenings pellets. Recent analysees for amino acid content carried out on pure samples of the various weed seeds found in refuse screenings show that the weed seed proteins are comparable with linseed, cottonseed and soya meals with respect to protein quality. These results have been confirmed by net protein utilization trials on representative samples of weed seeds. These trials indicate that many of the weed seeds contain proteins that are of comparable biological value to those of the soybean. As would be expected the weed seeds contribute appreciably to the relatively high fat level noted in the final refuse pellets. As far as can be determined this fat fraction is utilized by the animals fed on the refuse pellets.

(4) Weed Seed Devitalization: The safe use of refuse screenings as a feeding stuff is of course dependent upon complete devitalization of the weed seeds. The grinding process used in the fractionation of the raw screenings reduces the viable weed seed count to levels commonly found in normal feeding stuffs. To further ensure that all vitality is destroyed the fractionated screenings are

heated to a temperature of 205° F. with moist heat and held at this temperature for one and one half minutes. Early in the research on this feeding stuff it was discovered that the weed seeds are very susceptible to heating it is is carried out in the presence of moisture. This finding confirms earlier results reported by the laboratories of the Canadian National Research Council. Prolonged heating is required in the absence of moisture. In fact the amount of heat required under such circumstances is so great that it makes devitalization with dry heat uneconomic. Extensive tests for weed seeds vitality have been carried out on the devitalized pellets by the Plant Products Division of the Canada Department of Agriculture. Their studies show that the processing procedure that has been evolved is completely effective and ensures a vital weed seed free product. Feeding trials with raw unheated and unground refuse screenings show that most of the weed seeds pass through the digestive tract of the bovine or sheep without breakdown. This indicates that the net yield of the weed seeds pass through the digestive tract of the bovine sheep without breakdown. This indicates that the net yield of nutrient energy to the animal consuming such screenings will be measurably below that obtained on the processed material.

(5) Feeding Trials:

(a) Acceptability of the Feed to Animals: Extensive laboratory and field scale trials show that the pelleted refuse screenings are completely palatable. It has been standard practice to give animals that are being placed on refuse pellets a very light feeding of hay the night before bein g placed on feed. Acceptance of the pellets the next morning has been excellent. Where animals have been on a grain or other feed pellets it has been our custom to substitute refuse pellets for the other feed at the rate of twenty per cent per day until after five days the animals are consuming only the refuse pellets. This procedure is followed to allow at least a short time for the adjustment of the rumen microflora to the new feeding stuff. Trials have been carried out in which cattle have been placed on full feed on refuse pellets immediately on entering the feed lot. In these cases they are offered four pounds of hay per head first and then when the hay is cleaned up they are offered all the refuse pellets they will consume. In no case has scouring been encountered. Ci rcumstantial evidence suggests that the normal fiber level of the refuse pellets (14-15%) is close to the optimum required to maintain normal ruminal activity without digestive upset. For commercial feed lot use this feature of the refuse pellets has been most useful.

(b) Growth rate of Refuse Screenings Pellets: A great many feeding trials have been carried out with cattle in various weight categories. Cattle in the weight range 400 to 700 pounds maintain a gain of 1.8 to 2.0 pounds per day. Cattle ir the range 600 to 900 pounds maintain a gain of 2.0 to 2.3 pounds per day. In these trials hay intake was reduced to 0.6 pounds per hundred pounds body weight per day. This level of hay intake was selected to encourage maximum pellet consumption and for the more practical reason that under feed lot conditions hay is a fairly expensive commodity in terms of original cost and labor cost of handling. In comparative trials with feed based on the regular grains refuse fed cattle in the lighter weights appear to gain at the same or nearly the same rate as comparable animals on grain feeding. There can be no doubt that the energy yield from the refuse pellets is slightly below (probably about 10%) the regular feed grains but under feed lot conditions the slightly lower energy yield per pound of feed is more than compensated for by the avoidance of scouring and digestive upsets. On that basis of records on some 20,000 head fed on refuse pellets no mortality has occurred that could be attributed to the feed.

(c) Feed Efficiency: On young cattle in the weight range 400 to 700 pounds the feed efficiency has averaged under Vancouver conditions 5.5 pounds of pellets and 2.0 pounds of hay per pound of weight gained when the pellets were hand fed at the full feed level and hay was fed at 0.6 pounds per hundred pounds body weight. On cattle in the weight range 600 to 900 pounds the corresponding figures have been 7.5 pounds of pellets and 2.2 pounds of hay per pound of gain. Large scale commercial field trials under the same conditions indicate that these efficiency figures can be realized under such conditions. Insufficient research has been carried out to yield efficiency figures for cattle in the weight range 900 to 1200 pounds. Preliminary figures suggest that the efficiencies will be 9 pounds of pellets and 2.3 pounds of hay per pound gain.

(d) Digestibility of Refuse Screenings Pellets: Time and facilities have not permitted the conduct of regular digestion trials with this product. Estimates based on rate of gain data at various levels of feed intake suggest that the total digestible nutrient content will be approximately 70% and vary around this point to some extent depending upon the level of fat. The digestible crude protein level appears to be between 8.5 and 10%.

(e) Apparent density: Increasing attention has been given to the density of feeding stuffs with the advent of pelleting since there is good evidence to suggest that rate of gain and feed efficiency can be improved by raising the apparent density or mass per unit volume of feeding stuffs. For this reason the apparent density of refuse screenings pellets has been measured in comparison with other common feeding stuffs. The results are given in Table III.

Table III Apparent Density of Refuse Screenings Pellets

Feeding Stuff	Pounds per Cubic Foot
Ground Raw Refuse Screenings	23
Pelleted Devitalized Refuse	44
Pelleted Dehydrated Grass	44

Pelleted Grain base Steer Ration containing oats	33
Pulverized Oats	28
Pulverized Barley	33
Soybean meal	38
Linseed meal	38

The relatively high apparent density of the refuse pellets can be accounted for on the basis of the fine grinding that they are subjected to and to a small degree to their higher ash content (7.0%). The difference in density between the raw ground screenings and the same material in pellet form may explain in part why feeding results with the pellets have shown distinct superiority.

(f) Carcass Quality: On all trials to date carcass quality has been completely comparable with that obtained with regular feeds. There is a tendency for the carcass fat to be whiter than on the regular feeds but in most cases this difference is most acceptable to the meat packer. No evidence of taint or off flavour has been encountered in cattle full fed on refuse pellets right up to the day of slaughter. It has been usual to take the cattle off feed and on to hay 24 hours prior to slaughter but this procedure is not essential.

NUTRITION OF CAGE LAYERS

Rollin H. Thayer, Professor
Department of Poultry Husbandry
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The problems encountered in feeding cage layers are different from those ch must be dealt with in feeding layers held under floor conditions. The layer on which is fed to cage layers must be complete in all nutrients which are re- ed for high egg production. Hens confined to cages have no opportunity to pick utrients from the litter. In many cases it is also difficult to supplement the ration minerals such as calicum carbonate which under floor conditions can be fed free ce in hoppers. All required nutrients in the proper balance must be provided e ration which is fed. If this is not done, nutritional difficulties are apt to be untered.

Layer hens held in cages are subjected to more severe stress than is normally untered under floor laying conditions. The layers are confined in small s isolated one from the other. In this position they are more sensitive to en changes in temperature. They seem to suffer more from high temperatures perhaps require more nutrients to maintain body temperature when air tempera- s are low. The abnormal environmental conditions seem to intensify any nutri- l deficiency or imbalance which might be present in the layer ration.

Cage operators try to obtain layer hens which have a high genetic potential gg production. These hens require a nutrient intake which will support this egg production potential. If it is not provided, the stress of heavy egg produc- soo brings about marginal nutrition deficiencies which cause a break down of en and lowered egg production.

The ideal layer ration towards which all poultry nutritionists are working ave all of the essential nutrients in the proper amounts and proper balance. we are somewhere on the road toward the development of this ideal ration. progress along this road and the demands of egg production become higher gher it is more and more essential that nutrients be at the proper balance vel in the ration. In addition, as we approach this goal, we have more and nutrients to take into consideration. Some nutrients which were not critical er levels of egg production become so as egg production is increased. Thus lation becomes more and more complex as the ideal ration is approached ore and more problems must be solved if adequate cage layer nutrition is realized.

Nutritive requirements of cage layers in light of these developments, there- cannot be thought of as individual requirements. In all cases the ration f a given nutrient will depend upon the level of other nutrients in the The protein level in a layer ration will be determined by the energy level ration.

The same is true of minerals and vitamins. Thus requirements must be thought of in terms of the egg production which is to be expected and the level of other nutrients in the layer ration which is to be fed.

The protein requirement of layer hens has been expressed as a percent of the total ration. Since many factors must be considered in setting up this requirement level, percent of ration becomes meaningless in so far as protein requirement are concerned. It would be much more logical to think in terms of the daily quantity of protein which is required by a layer hen. This daily quantity will be determined by the size of the hen, the rate of egg production, and the quality of the protein which is being fed. When these factors have been considered and the daily quantity of protein which is needed has been determined, the percent protein in the ration will depend primarily on the amound of feed which a given hen will eat in a day. Thus the percent of protein in a ration should vary inversely with feed consumption. It has been established that feed consumption does increase with an increase in rate of egg production and for this reason the protein intake of the hen would be increased with increased egg production. However, if environmental temperatures are high, feed consumption tends to go down. This in turn limits the amount of protein intake per day. In addition, as the energy content of the ration is increased, the amount of feed which the hen will eat is decreased. Unless these factors are considered, regardless of the protein level in the ration, the protein intake may be inadequate for maximun egg production.

The mineral requirements of cage layers must be fully met if eggs are to be produced with good egg shells. Much research needs to be done to study the levels of the individual minerals as well as the important interrelationships which must exist. Since the feeding of supplemental mineral is somewhat of a problem in cage layer feeding it is essential that all the minerals which are required for heavy egg production be included in the layer maxh itself. Since all hens are not laying at the same rate and do not have the same mineral requirements this becomes a difficult problem with which to cope. It has been observed at the Oklahoma Experiment Station that phosphorus requirements are perhaps more critical than are calcium requirements for layer hens. For this reason the proper amount of phosphorus as well as phosphorus in a form which is available to the layer hens must be provided. This means that in most cases the total phosphorus level in a ration should be approximately one percent which provides an available level somewhere near the requirement.

In studies with layer hens at the Oklahoma Experiment Station it was found that layer hens required vitamin levels in excess of NRC allowances if egg production was to be maintained at a high level over a long period of time. Layer rations containing lower levels of B-complex vitamins did an excellent job during the first 3 or 4 months of the laying period. After that time egg production gradually declined in those lots which were provided the B-complex vitamins at NRC allowance level. The layers which were receiving vitamins at from 2 to 3 times the NRC allowances declined in egg production, but the decline was less pronounced and high egg production was maintained over a much longer period of time. Recent observation at the Washington Experiment Station would indicate that breeder hens fed a ration containing adequate levels of B-complex vitamins produced chicks which showed symtoms of B-complex vitamin deficiencies at some time during the growing period. This emphasizes the fact that NRC allowances as recommended at the present time are not adequate for maximum egg production.

The nutrition of cage layers, therefore, has become increasingly complex during the past year or two. Nutrient requirements must be determined not as isolated requirements, but as each is related to other nutrient levels in the layer ration. This problem of nutrient interrelationships will become more pressing in the immediate future unless more basis information on nutrivive requirements becomes available.

MANAGEMENT AND ECONOMICS OF LAYER PROGRAMS IN NORTH CENTRAL STATES

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In some respects cage laying buildings and cage laying management problems in northern climates are different than those in areas of less severe winter climates. Most of the new cage buildings are windowless which saves on building costs and makes it possible to have better insulated buildings but this means that all lights must be artificial and ventilation must be by forced methods. Because of added building costs cages in northern states are usually, but not always double-decked. Double-decking the cages introduces a couple of more problems in that disposal of manure becomes more difficult and cleaning the water trough is much harder. Usually there is a dropping board under the top deck which of course must be cleaned more or less regularly. This is sometimes done by hand but mechanical cleaning equipment for both top and bottom decks is available.

The water troughs should be cleaned regularly and commercial devices consisting of brushes on long steel tapes are available for the purpose but our own experience is that homemade devices consisting of a sponge wrapped around a bolt and attached to a plastic clothes line also does a satisfactory job of cleaning. If the brush is dipped in a solution of household detergent or a commercial quarternary ammonium compound cleaning is facilitated. It is sometimes advisable also to use a weak solution of copper sulfate occasionally not only to destroy any algae or fungi in the trough but also as a treatment for any birds that may be affected by diseases caused by fungi. Incidentally, anyone going into cage operations should have the water supply checked both for bacteria and chemical salts.

Cage fatigue is frequently seen in caged layers particularly in the first few weeks after housing. This condition which is more widely observed in some areas than in others does not seem to be nutritional in nature nor has any causative organism been shown to exist. Usually birds recover spontaneously if placed on the floor with food and water readily available or if an egg flat is placed under them in the cage with feed and water at a level they can reach.

Fly control is another problem in all areas. Fly baits consisting of Malathion with sugar and sometimes dried whey as an attractant are successfully used inside the buildings. Malathion spray may also be used on inside walls. Diazinon spray may be used outside the building but should not be used on the inside. Super phosphate or lime sprinkled on the droppings aid in drying the droppings and therefore reduce odor in the cage house. These materials do not however kill fly larvae. Birds should be checked for external parasites before caging and if internal parasites are a problem, treated at time of caging.

Feeding methods vary from operator to operator, but in general a complete fee rather than mash and grain is preferred. Most feed manufacturers make a feed tha contains sufficient calcium that oyster shell need not be added although sometimes t recommendation is made that supplemental shell be used particularly in the first fe months of production and also during the latter part of the bird's laying year. It is our experience that mash is as good as crumbles though it may be slightly more difficult to control wastage. Pellets as the sole feed seem to encourage billing out but a pellet supplement on top of an all mash ration may increase total feed consum tion and improve egg production. A strip of hardware cloth cut to lay on top of the feed in the trough may reduce the amount of feed billed out, and thus reduce wastag

A typical northern climate cage house will have about one bird for each 1.4 squ feet of inside space. According to prices quoted by one manufacturer last year ma cost of a complete building including ventilating equipment and laying cages would b about $4.00 per bird. A considerable amount of the owner's labor would also be involved but at that price would compare favorably with the cost of a well-built floo building. Of course mechanical cleaning equipment would add to the cost and the amount would depend on the size of cage and other factors but with an 8-inch cage would not be over about $1.40 per bird, including cross conveyors. Automatic egg counters cost about 25¢ per bird. Many cage buildings use trusses so that posts which would otherwise interfere with cage placement are not necessary. That method of course adds to the cost of construction. Some operators have gone ahea and used posts for center supports and cut out the corner of one cage and by remov one cage partition at each post and putting two birds together have not sacrificed a total cage capacity.

Evaporative type coolers are frequently used in newer cage houses in areas w the buildings are completely enclosed. These coolers work best if the relative humidity is 50% or below. In fact as the relative humidity approaches 70% or ther abouts, the birds seem more comfortable if the water is turned off and the fans alone used.

Culling, in my opinion, is sometimes overdone. It is preferable not to cull except for obviously unfit birds until the most of them have reached sexual maturi We prefer not to cull, except for sick or unthrifty birds, as long as production sta at 75% or better.

ENERGY - PROTEIN RELATIONSHIPS WITH GROWING TURKEYS

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The larger size turkeys eat about three-fourths of their total feed requirement during the last half of the growing period. Since the most emphasis has been given to the turkey's nutritive requirements up to 8-10 weeks of age, a real need is for more information on their nutritive requirements during this latter period. Much of the fundamental information used today in making recommendations for and in formulating turkey feeds for this latter period, has been taken from work conducted with chickens. Some information is available on feeding systems for turkeys during this period, in particular on the use of varied proportions of mash and various single grains or grain combinations. When given a free choice of mash and grain, turkeys will consume increasing proportions of grain as they get older. Most recommendations for protein and energy requirements are based upon these observations, i.e. the protein requirement drops and the energy requirement increases. As more and more turkey growers are considering the use of all-mash pelleted feeds, more precise information is needed on these requirements, particularly as they may vary with age and stage of development.

Recent results from this station have indicated that during the 12 to 20 week period, energy levels may vary quite widely without affecting the rate of growth. The most economical growth rates during these later tests however, have been with the higher energy feeds. In considering oats versus corn as the primary source of energy, oats is the cereal of choice, only when its cost is less than 70%, by weight, of that of corn. During this 12 to 20 week period also, protein levels of 19% have been indicated as being the most satisfactory. Though direct comparisons from the same experiment are not too conclusive in this regard, growth rates in later studies where 19% protein pelleted diets were used far exceeded that obtained earlier with 16% protein all-mash diets. Better starter diets and pelleted grower diets probably accounted for much of this difference, but protein level must have played an important part. High energy 19% protein diets with a Calorie-protein ratio of 45:1 gave only slightly better growth rates than low energy 19% protein diets with a C:P ratio of 35:1 in these later studies.

For the 20 to 24 week period the data show that the protein content of the ration can be dropped to as low as 14% with satisfactory results. Studies in which the C/P ratios were increased from 45:1 to 60:1 and 70:1 continued to show slightly better growth rates than those in which the C/P ratios were increased from 35:1 to 43:1 and 53:1 during this period.

This work also indicates that the energy content should be increased still higher during the finishing period. A diet with a C/P ratio of 80:1 gave growth superior to that obtained before on a 60:1 C/P ratio and also superior to the diet in the same study with a 63:1 C/P ratio. Finish was also much improved by the wider C/P ratio.

Further work is necessary to clearly establish what the optimum C/P ratios and protein levels should be for growing turkeys from 12 weeks of age to market size. On the basis of this work it is suggested that 19% protein diets be used to at least 18-20 weeks of age, with energy levels between 700 and 900 Calories per pound. The choice of energy level depends upon the relative cost of ingredients and their relative efficiency of production. From 20 weeks and on, protein content can be dropped to 14% or possibly less, and the higher energy levels of from 900 to 1000 Calories per pound should be used for maximum growth rate, feed efficiency, and development of finish. Thus oats or other low energy ingredients may be used extensively during the 12 to 18 or 20 week period, but some corn or milo or other higher energy source must be used during the finishing period.

THE PROBLEM OF AORTIC HEMORRHAGE IN TURKEYS

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Since the early 1950's certain trukey growers have been bothered by loss of birds in their flocks due to massive internal hemorrhage. Healthy, large toms are most susceptible to this occurrence. On examination, the heads and necks of the recently dead birds are pale but otherwise the bird is in good condition. Upon autopsy it is observed that blood (usually clotted) has filled the body cavity, and in some cases the lungs and mouth. The mortality due to this problem is usually under 5% of the flock, although loss up to 20% has been reported. These birds die usually between eight and 16 weeks of age, thus economic loss involved is quite significant.

When the viscera are removed from the turkey, the posterior aorta (a major blood artery) has developed a dissecting aneurism through the layers of the artery so that blood leaks into the body cavity. The rupture in this vessel usually occurs in the area of the kidneys between the iliac artery and the rear junction of the aorta where it divides into the sciatic arteries.

About a year ago, University of Wisconsin scientists reported that a similar type of hemorrhage in young turkey poults could be produced by feeding a chemical called beta-aminopropionitrile (BAPN). In experiments by Dr. Pomeroy and the author at the University of Minnesota following the Wisconsin report, older turkeys were used and it was found that similar hemorrhages could be produced with BAPN in older turkeys as well. On gross inspection of the affected birds, it was evident that this hemorrhage was indistinguishable from that observed under field conditions. Less than 90 grams (1/5th of a pound) of pure BAPN per ton of feed fed to young turkey poults produced hemorrhage in more than half of the turkeys between the ages of seven and 13 weeks. Thus a tool for studying this hemorrhaging problem is abailable.

It was thought that perhaps BAPN or a chemical relative was getting into turkey feeds and causing the problem in the field. However, with the analysis methods available, it has not been possible to detect any significant amounts of this compound in poultry feedstuffs. Also, the fact that birds on similar management and feeding programs reacted differently suggested that the causative agent of the field problem was fairly complex. In view of the many possible management factors that might influence the production of this problem, a questionaire was distributed to turkey farmers in an attempt to rule out or isolate certain important factors that might have a bearing on the problem. Since over 100 questionaires have now been returned, a summary of this survey has been prepared and is shown in Table 1.

For convenience, all qualified replies were divided into four categories depending on severity as shown in Table 1. The following factors were summarized for these incidence groups:

1. Relative breed incidence - Broad Breasted Bronze and Broad Breasted White turkeys both showed susceptibility to the problem. It is difficult to evaluate the effect of genetic factors on the incidence of this problem. The 72 questionnaires reporting fatalities obtained poults from 32 different hatcheries. It is possible, however, that certain birds show greater tendency toward the aortic weakness than others.

2. Management - Poults started on both litter and and wire mesh floors were susceptible to the problem. In the growing period, range birds and turkeys maintained under confinement conditions were susceptible to the problem.

3. Feeding program - The type of feeding program employed did not seem to materially affect the incidence of the hemorrhaging problem. Most of the growers in all incidence groups were using a pre-starter program with crumbles during the starting period. They were also employing a free-choice balancer-grain system during the growing period. The use of corn as the only grain did not appear to be responsible for the problem.

4. Disease program - Results showing diseases reported and types of treatment employed did not reveal a differential picture as to why the hemorrhage resulted. While coccidiosis appeared to occur only in flocks affected with hemorrhage, it is also evident that only 10-15% of the growers in these groups reported a problem with coccidiosis. A similar condition occurred with the use of sulfa drugs and 4-nitrophenylarsonic acid.

5. Flock Performance - According to the results obtained, there appeared to be a year to year incidence relationship on various farms, that is, farmers reporting high incidence for 1957 also reported a relatively high incidence for the two preceeding years. This tends to agree with field observations, where certain farmers seem to be affected with the problem quite frequently.

The summary of leg disorder incidence indicates that more than half of the farms reporting hemorrhage also reported leg disorders in the same flocks. The writer doubts that this is meaningful since it is quite well accepted that most flocks have some leg problems. Practically all growers reported satisfactory weight gains.

Causes and Future of This Problem

The cause of this problem is not known at this time. The author feels that feeding changes over the past ten years, producing faster and more efficient growth, have placed increased stress upon certain turkeys under specified conditions resulting in the weakest point giving out first. Physiologically, the problem resembles to some extent the occurrence of atherosclerosis in birds and from this standpoint may be connected with lipid metabolism. It cannot be traced directly to the use of added animal fats in feeds, since in many instances the problem is severely present when animal fats were never used, except possibly in the form of meat scraps.

Diets have been lessened in their contents of certain unsaturated fatty acid sources in recent years. For example dietary fish, soybean oil, and wheat oil have been removed or reduced from rations by formulation and meal processing changes.

Other factors which have increased the rate of growth and changed the overall nutritional balance include the use of higher energy and protein diets, increased vitamin fortification levels, antibiotics, other growth stimulants, and the reduction in alfalfa levels thereby reducing the dietary content of vitamins E and K.

It also appears that early hatched poults are most severely affected with this problem, and it is felt that temperature may play an improtant factor in the amount of growth attained. Birds grown in hot weather would not eat as much feed and consequently would not grow as fast as earlier hatched birds.

It appears that this questionnaire has assisted in ruling out certain possible management factors concerned with the problem aortic rupture. Many dietary modifications can be suggested and should be tested in an effort to combat this problem. If nutrition dies represent a major cause of this problem, it should be possible to put the diet back in optimum balance without sacrificing growth rate in the process.

Table 1. Results of Turkey Hemorrhaging Survey

	INCIDENCE GROUPS OF HEMORRHAGING			
-	0%	0.0-1.99%	2.0-3.99%	4.0-20%
Number of questionnaires	17	52	20	13
	%	%	%	%
RELATIVE BREED INCIDENCE:				
Broad Breasted Bronze	65	73	70	92
Broad Breasted White	29	27	25	8
Beltsville Small White	6	0	5	0
MANAGEMENT:				
Poults starting on:				
Litter	76	65	55	62
Wire-mesh floor	24	35	45	38
Growing period:				
Range, %	76	87	75	69
Av. Age to range	(8.1 weeks)	(9.1weeks)	(9.7weeks)	(10.7 weeks)
Wire or slat floor, %	24	12	20	8
Pole barn, %	0	1	5	23
FEEDING PROGRAM:				
Starting:				
% using Pre-Starter	71	71	90	77
% using crumbles	76	77	95	69
Growing:				
% using "free-Choice" system	76	81	65	69
-mash-corn-oats	35	38	35	31
-mash-corn	12	8	5	0
-pellets-corn-oats	24	27	10	31
-pellets-corn	5	8	15	7
% using "all mash" system	24	19	35	31
-mash	18	14	30	23
-pellets	6	5	5	8
DISEASE RECORD:				
Diseases Reported:				
Blackhead	12	23	10	0
Bluecomb	18	13	15	8
Coccidiosis	0	10	10	15
CRD	0	2	10	0

Enteritis	0	2	0	0
Type Treatment:				
Streptomycin	6	2	0	8
Penicillin	6	2	0	8
Chlortetracycline	6	6	0	0
Oxytetracycline	6	4	15	23
Sulfaquinoxaline	0	6	5	18
Sulfa-drugs	0	10	10	8
2-Amino-5-nitrothiazole	6	12	0	0
Furazolidone	6	4	0	0
4-Nitrophenylarsonic Acid	0	13	10	8
Product Mixture*	0	4	0	0
FLOCK PERFORMANCE:				
Average age at death	(0.)	(13.9weeks)	(11.3weeks)	(12.1weeks)
Average Mortality, 1957	0	.8	2.3	5.3
Average Mortality, 1956	.35	.7	1.7	4.5
Average Mortality, 1955	.23	.8	1.0	2.4
% 1957 flock with leg disorders	36	53	80	64
% 1957 flock showing good gains	100	91	100	99

* A mixture containing acetyl-(para-nitrophenyl)-sulfanilamids, dibutyl dilsurat dinitrodiphenylsulfonylethylene diamine, and 3-nitro-4-hydroxyphenylarsonic acid.

LATEST CONCEPTS IN TURKEY NUTRITION

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A comparison of the nutritive requirements of growing turkeys with the nutritive requirements for the growth of other classes of livestock shows that the turkey has a much higher nutritive requirement than do other classes of livestock. This is not surprising when the nutrient levels in trukey meat are determined. Research data reported by the Cornell Experiment Station indicates that the protein content of turkey meat is much higher than that of any other market animal. In addition, vitamin levels are a great deal higher. This is in line with the greater requirement of the growing turkey for these nutrients in the growing ration.

During recent years, turkey breeders have made tremendous advancements in improveing the growth rate of market turkeys. It is doubtful that turkey nutritionists on the other hand have been able to keep pace with these advancements. As a result market turkeys are not growing at their maximum genetic potential because certain basic nutrient requirement data are not known.

Feeding trials in which the energy and protein requirements of growing turkeys have been studied have been conducted over a protein range which did not exceed a maximum of 32 percent of protein. Because of mixing and formulation difficulties it has not been possible to provide protein levels in excess of 32 percent and at the same time supply an adequate calorie intake. Some studies have been conducted on vitamin requirements, but these requirements were determined at lower protein and energy levels. The same situation holds in so far as mineral research is concerned.

A series of feeding trials were initiated at the Oklahoma Experiment Station about two years ago in order to determine the protein and energy levels which would be needed to produce maximum growth in growing turkeys. An experimental ration was developed in which the protein level could be varied over a range from 24 percent to 36 percent. This ration was also formulated in such a way that the required calorie-protein ratio could be maintained regardless of protein level. A number of feeding trials were conducted in which the turkeys were grown to 8 weeks of age. At the present time a feeding trial is under way using these experimental rations in which the growing turkeys will be grown to standard market weight.

At 8 weeks of age the turkeys which were fed a standard turkey starter containing 28 percent protein averaged 3.83 pounds in body weight and required 1.85 pounds of feed per pound of turkey produced. In comparison the turkeys being fed the experimental rations averaged 4.35 pounds in body weight and required 1.32 pounds of feed per pound of turkey produced. This represents a 13 percent increase in body weight and a 30 percent decrease in the amount of feed required to produce a pound of gain. At ten weeks of age the control turkeys averaged 5.44 pounds in body weight and required 2.18 pounds of feed per pound of turkey produced. At this same age the experimental birds weighed 6.16 pounds and required 1.48 pounds of feed per pound of turkey produced.

The data obtained in these studies would indicate that there was a plateau in growth at an approximately 32 percent of protein. Differences in body weight between the 32 percent protein rations and those containing 36 percent protein were non-significant. However, there also was a steady improvement in the efficiency with which the feed was converted between these two protein levels. It would appear that the growing turkeys were able to consume enough feed at the 32 percent protein level to maintain a near maximum rate of growth. At the 36 percent protein level, however, their need for protein was supplied by a smaller amount of feed and feed efficiency was improved. These facts would point to the possible deficiency of one or more amino acids at the 32 percent protein level. Preliminary feeding trials indicate that arginine, lysine and tryptophan may be limiting at these protein levels.

The grower rations used in this series of studies are of a practical nature with the exception of one or two ingredients. The greatest need in making a practical application of these basic findings is for a very concentrated source of protein of extremely high quality and a source of fat which is in a powder free-flowing form. Unless these two products become available or unless lower protein levels can be utilized, formulating and mixing problems will make the use of these feeds impractical. However, these results do indicate what can be accomplished and provide a goal toward which the turkey producer can move.

ANTIBIOTICS FOR LAYERS

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Numerous reports have appeared concerning the possible effect of antibiotics upon egg production. Many of the earlier reports indicated little or no effect from low levels (2 - 10 gm.) of antibiotics, including penicillin, streptomycin, oxytetracycline and chlortetracycline. Data have been published which conflict with these reports and which indicate that the use of low levels of antibiotics has resulted in increased egg production. These conflicting reports suggest that different environmental conditions, "degrees of infection", or actual rates of performance influence whether or not such low levels are effective. In general, the higher levels of antibiotics, particularly those of the tetracycline group, have shown a more consistent improvement in egg production. These effects have been most marked when production rates have dropped off as a result of disease incidence.

Data will be reported from the result of six years work on this problem at the South Dakota Station which show the following:

1. Low levels of penicillin (2 - 4 gm./ton) have slightly but consistently improved egg production and hatchability economically.
2. High levels of antibiotics (30 - 100 gm./ton) have improved egg production and hatchability, to a somewhat larger extent, but not in every instance economically.
3. Arsanilic acid (90 gm./ton) has produced an economical increase in egg production.
4. The combination of arsanilic acid (90 gm./ton) and penicillin (4 gm./ton) has shown some antagonistic effects upon egg production.
5. The further additions of furozolidone (25 gm./ton) or furizolidone (15 gm/ton) and nitrofurazone (15 gm./ton) to a diet containing penicillin (4 gm./ton) improved egg production of commercial egg-type hybrids in cages, but the additions did not produce as marked or consistent effects upon the egg production of the native S.C.W.L. stock in either floor pens or cages. Feed efficiency was markedly improved in floor pens by these additions as well as by chlortetracycline (20 gm./ton). The latter did not improve egg production, but appeared to cause a decrease with the caged S.C.W. Leghorns. Similar detrimental effects were noted with oxytetracycline (20 gm./ton) additions to the penicillin containing diet for caged W. P. Rocks. A small improvement in egg production through similar oxytetracycline use was noted with W. P. R. hens in floor pens.
6. The antibiotics, nitrofurans or arsenicals have shown little effect upon egg size, egg interior quality or progeny growth. Mortality was reduced somewhat by the high levels of antibiotics.

The results indicate that antibiotics, nitrofurans, or arsenicals have been valuable additions to laying and breeding diets under some conditions. Hens laying at a relatively low rate or producing eggs with below average hatchability were improved most by dietary supplementation. Which supplement, level of supplement, or combination of supplements to use is dependent upon each situation. Until further information is available as to the reason for the antagonisms, it would seem that penicillin and arsanilic acid as here tested should not be used together, and that a combination of the tetracyclines with penicillin as here tested should be avoided for caged layer flocks. Low levels of penicillin (up to 10 grams per ton) or the combination of penicillin (4 gm. /ton) and furizolidone (25 gm. /ton), or arsanilic acid (90 gm. /ton) or high levels of antibiotics (50 - 100 gm. /ton) in most cases have been economical in improving reproductive performance under the conditions of this station and have not shown any detrimental effects. Other work indicates that combinations of penicillin with streptomycin or bacitracin may be beneficial.

RUMEN MICROBIOLOGY AS RELATED TO CONCENTRATES AND ROUGHAGES

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The dairy industry hinges on the economical conversion of forages and grain supplements to milk and meat. This is made possible by the large size and the forward location of the fermentation vat (rumen, reticulum, omasum) where microbes live. These countless billions of bacteria that are present in this fermentation vat break down coarse feed into simple compounds that the host animal uses. Actually there are two kinds of microbes in this vat, bacteria and protozoa. The bacteria are believed to be the most important form of microscopic life. The function of protozoa is not understood.

When old bossie swallows forage, it passes to the rumen where the bugs swarm over it hunting for cracks to penetrate. The microbes produce enzymes that do the actual digesting. The tough long pieces are brought back into the mouth for another going over. We call this cud chewing.

Probably the most important parts of the forage that are broken down by microbes are carbohydrates. These include crude fiber and nitrogen free-extract as well as sugars and starches. The cow does not produce enzymes that digest the fibrous part of forage, that makes up more than 50 percent of the dry matter, but depend on those produced by microbes. This is of great economic importance since that forages supply cheap energy.

These sources of energy are broken down by the rumen microbes to short chain fatty acids and gases. The acids are principally acetic, propionic and butyric. These acids pass through the rumen wall into the blood stream and pass to the liver. The total energy supplied by volatile fatty acids plays an important role not only in energy relations, but in other respects as well.

A certain amount of acetic and butyric acids are essential for optimum butter fat production. In experiments with high grain, limited hay, the percent of fat in milk declined. It appears that 8 to 10 pounds of hay per cow per day is needed for this purpose. There is some evidence, however, that the feeding of grain mixtures low in starch may not lower the test.

The cause or causes of ketosis is not known other than the effect of stress. There is some evidence that the feeding of rations that bring about the production of greater quantities of propionic acid may help in the prevention of ketosis. Lactates have been used for the treatment of this condition.

Rumen microbes make a great contribution to the cow, but the many good things that they build up is also important. They are capable of taking low grade protein and even nitrogen compounds such as urea and make a high class protein for the cow. This explains why quality of protein is not so important in the nutrition of dairy cows.

The bugs of the fermentation vat, also have the ability to make many vitamins for her own use and to put into milk. Vitamins A, D and E cannot be made by the microbes or by the tissues of the cow, but must be supplied in the ration.

The pay off in rumen studies is to know how to direct microbial fermentation so that the cow makes good use of roughage. Considerable progress has been made in learning how to supplement poor roughages such as cereal straws and corn cobs. When corn cobs are balanced with protein, cereal grains, minerals and vitamins there is still a factor lacking that is needed for proper digestion. Alfalfa ash or valeric and iso-valeric acids appear to supply the missing factor or factors.

Apparently, the necessary rumen factors are supplied with good forage crops and grain supplements. This is the possible explanation for the failure of many rumen preparations, and yeast to bring about increased growth of milk production. As a matter of fact the greater use of high yielding forages with a lot of built-in-grain means a strong dairy business that sould result in a stronger feed industry.

[redacted]